

The Quantum View of the World

Boston - Oct. 1982

Introduction

1. In November 1979 Prof. D'Espagnat published an article in Scientific American with the title 'The Quantum Theory and Reality!'. The sub-heading read as follows:
"The doctrine that the world is made up of objects whose existence is independent of human consciousness turns out to be in conflict with QM and with facts established by experiment"

- Created a furor among physicists
well what are these experiments which enable us to do experimental metaphysics?

2. On 28th Aug. 1981 The Times carried a report headed 'Random events over-run Einstein'.

In what sense is this claim true?

3. Interaction of philosophical and scientific problems in the understanding of QM.

Book 51

← Phil. of Phys. Phys. →

-100 -1 0 +1 +100

4. Minimal instrumentalist (statistical) interpretation of QM used by physicists.
But Einstein, Schrödinger and Bohm sought to provide a 'conceptual understanding' of

Now form

$$\begin{aligned} \gamma_n &= a_n b_n + a_n b_n' + a_n' b_n - a_n' b_n' \\ &= a_n (b_n + b_n') + a_n' (b_n - b_n') \end{aligned}$$

So $\gamma_n = \pm 2$.

$$\frac{1}{N} \sum_{n=1}^N \gamma_n = c(a, b) + c(a, b') + c(a' b) - c(a' b')$$

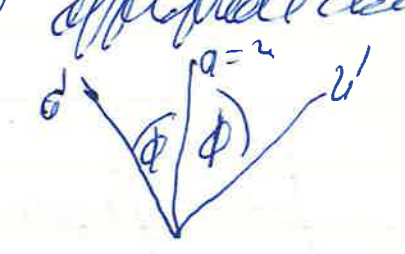
where $c(a, b) = \frac{1}{N} \sum_{n=1}^N a_n b_n$, etc.
 $c(a, b)$ are correlation coefficients.

$a_n b_n$ = covariance of random variables a_n, b_n

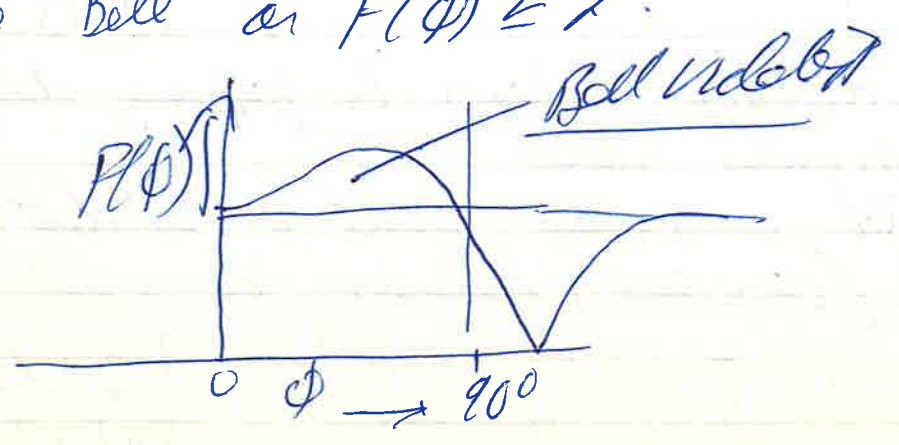
(V.B. Correlation Coeff. = $\frac{\text{Covariance}}{\sqrt{\text{product of variances}}}$ in this case variances are all 1)

Then in the Bell inequality -

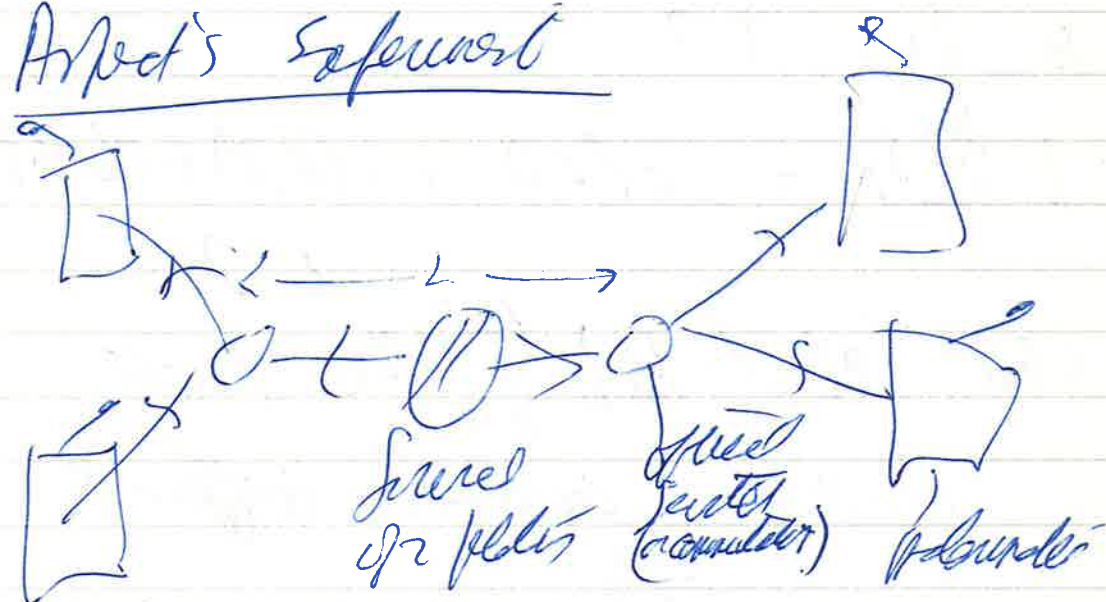
It is violated by QM for appropriate choices of directions a, a', b, b' for all directions coplanar



Write Bell as $F(\phi) \leq 2$.



Arpa's Safeword



Signal is provided by a very high frequency acoustic wave standing wave induced a crystal - acts as a variable diffraction grating
Modulation frequency is of order 200 MHz.

$$L = 6 \text{ metres} \quad \frac{L}{c} = 2 \times 10^{-8} \text{ sec} \\ = 20 \times 10^{-9} \text{ sec} \\ = 20 \text{ nanoseconds}$$

$$\text{freq frequency} \approx \frac{10^8}{2} \approx 50 \text{ Billion cycles/sec} \\ = 50 \text{ MHz}$$

NB. Modulation of beam by frequency double that of acoustic waves.

Switch is driven with a random deviation of its frequency between 200 & 250 MHz.

$$T \approx 0.5 \times 10^{-8} \text{ sec.} \\ \Delta f \approx 10^{-8} \text{ sec.}$$

} So switch changes in $\frac{1}{2}$ + time of flight of wave from source to detector